RAINFALL AT HONOLULU IN RELATION TO BAROMETRIC PRESSURE AT MIDWAY ISLAND AND HONOLULU

551.578.1 : 551.54 (969)

By WALTER G. RAMSAY

[Weather Bureau Office, Honolulu, Hawaii, November, 1925]

An attempt has been made by the writer to find a relationship between barometric pressure at Midway Island and Honolulu and rainfall at Honolulu within the following 24 hours for the purpose of discovering a method of increasing the accuracy of the forecasts of rainfall at Honolulu. Although the attempt has been a failure in so far as finding a method of forecasting rain at Honolulu is concerned, the results of the study are not entirely devoid of interest.

For the purpose in view a tabulation was prepared showing the 8 p. m. barometric pressure, pressure change and wind direction at Midway Island and Honolulu for each day of 1924 and the 24-hour precipitation at Honolulu ending at 8 p. m. the same day. They furnish the basis for the tables and deductions in this paper.

From the table it was found that the average Honolulu barometric pressure for the year was 30 inches, and that the average barometric pressure at Midway Island was 30.06 inches. The average pressure at Midway Island for days on which 0.01 inch or more of rain fell at Honolulu was found to be 30.08 inches, while the Honolulu pressure for the same day was 30.03 inches.

The barometric pressure at Midway Island 24 hours before rain was measured at Honolulu was found to average 30.09 inches and the pressure at Honolulu 24 hours previous to recorded rainfall was found to average 30.03 inches. These two averages were made use of in the study, and were termed "rainfall pressure averages."

There were found to be four main divisions of pressure relationship between Honolulu and Midway Island in regard to barometer readings as compared with these "rainfall pressure averages." They were: Both Midway Island and Honolulu barometric readings above their "rainfall pressure averages"; Midway Island pressure above average and Honolulu below; Midway Island pressures below average and Honolulu above; and both below their "rainfall pressure averages."

Under each of these four main divisions there were found to be nine further divisions, as regards the pressure changes having taken place during the preceding 24 hours. These nine divisions were: Midway Island barometer rising and Honolulu barometer rising; Midway Island barometer rising and Honolulu barometer falling; Midway Island barometer falling and Honolulu barometer falling; Midway Island barometer falling and Honolulu barometer rising; both Midway Island and Honolulu barometers stationary; Midway Island barometer rising and Honolulu barometer stationary; Midway Island barometer falling and Honolulu stationary; Midway Island barometer stationary and Honolulu barometer rising; and Midway Island barometer stationary and Honolulu barometer falling. From this it is seen that there were 36 different combinations of pressure relationship possible.

Table A presents a summary of first, the total number of days with each of the possible pressure relationships; second, the number of days with rain at Honolulu that followed days with each of the combinations; and third, the percentage of days with rain as compared with the total number of days with each pressure combination.

From Table A it may readily be seen that there were 128 days during the year when both the Midway Island and the Honolulu barometers read above the rainfall pressure averages (that is, 30.09 inches at Midway Island and 30.03 inches at Honolulu). Of this number, 61 days were followed, within 24 hours, by 0.01 inch or more of precipitation at Honolulu; and 67 days without rain within the following 24 hours; that is, in 48 per cent of the cases in which both barometers were above the average, rain fell at Honolulu within 24 hours. With the Midway Island barometer reading above average and the Honolulu barometer reading below, there were 26 days with rain and 16 without, or 62 per cent rainy days following these conditions.

With the Midway Island barometer below average and the Honolulu barometer above there were 21 days with rain and 71 without, or 24 per cent rainy days. With both barometers below average there were 38 days with rain and 64 without; a percentage of 37.

Glancing down the third column of this table we find that the highest percentage recorded is 75, and that it is recorded with the Midway Island barometer above the average and rising, and the Honolulu barometer below the average and falling. That is, with these barometric conditions there is a 75 per cent probability of rain occurring at Honolulu within the next 24 hours. Further down the table we find that with the Midway Island barometer above average and stationary, and the Honolulu barometer below average and falling there is a 71 per cent probability of rain at Honolulu within 24 hours.

Turning next to Table B, we observe that when barometric pressure at Midway Island is above the average, there is the greatest probability of rain following days when the direction of the wind at the evening observation is northeast, east, or southeast. When the Midway Island barometer is below average, however, there seems to be the greatest probability of rain at Honolulu with a wind direction at Midway Island of northwest, southwest, or northeast.

Nothing definite can be drawn from this short study of pressure distribution and rainfall, because there has been discovered no one set of conditions when rain will invariably fall, or rain invariably will not fall. The most that can be said is this: That there seems to be the greatest probability of 0.01 inch or more of rain within 24 hours of the following conditions: Midway Island barometer above 30.09 inches and rising, with a northeast wind, and Honolulu's barometer below 30.03 inches and falling. In any event, it would seem that there is the greater probability of rain at Honolulu following a Midway Island barometer of over 30.09 inches, and a Honolulu barometer of below 30.03 inches.

It is more than likely that the pressure averages used may not be the correct ones, and that with further investigation the proper ones may be found. In the meantime, this preliminary study may serve to suggest further methods of finding a close connection between pressure or wind at Midway Island and rainfall at Honolulu. At present, even if the probability percentages as given are correct, none of them are sufficiently high to warrant their being used as a basis for forecast work, the ultimate object of the study.

TABLE A.—*Total number of days with each barometric condition, number of days with rain within 24 hours, and percentage of days with rain*

MIDWAY ISLAND AND HONOLULU ABOVE AVERAGE

Barometric conditions	Total rain	Days with rain	Percentage of days with rain
Midway Island rising, Honolulu rising	36	16	45
Midway Island rising, Honolulu falling	22	12	55
Midway Island falling, Honolulu falling	19	10	53
Midway Island falling, Honolulu rising	14	6	43
Both stationary	8	2	25
Midway Island rising, Honolulu stationary	6	3	50
Midway Island falling, Honolulu stationary	6	4	67
Midway Island stationary, Honolulu rising	10	4	40
Midway Island stationary, Honolulu falling	7	4	57

MIDWAY ISLAND ABOVE AVERAGE AND HONOLULU BELOW

Midway Island rising, Honolulu rising	5	3	60
Midway Island rising, Honolulu falling	12	9	75
Midway Island falling, Honolulu falling	9	6	67
Midway Island falling, Honolulu rising	0	0	0
Both stationary	1	0	0
Midway Island rising, Honolulu stationary	1	0	0
Midway Island falling, Honolulu stationary	3	1	33
Midway Island stationary, Honolulu rising	4	2	50
Midway Island stationary, Honolulu falling	7	5	71

MIDWAY ISLAND BELOW AVERAGE AND HONOLULU ABOVE

Midway Island rising, Honolulu rising	15	5	33
Midway Island rising, Honolulu falling	18	2	11
Midway Island falling, Honolulu falling	16	3	19
Midway Island falling, Honolulu rising	24	8	33
Both stationary	0	0	0
Midway Island rising, Honolulu stationary	7	1	13
Midway Island falling, Honolulu stationary	2	1	50
Midway Island stationary, Honolulu rising	9	1	13
Midway Island stationary, Honolulu falling	1	0	0

MIDWAY ISLAND AND HONOLULU BELOW AVERAGE

Midway Island rising, Honolulu rising	12	5	42
Midway Island rising, Honolulu falling	16	9	56
Midway Island falling, Honolulu falling	37	11	30
Midway Island falling, Honolulu rising	18	6	33
Both stationary	3	0	0
Midway Island rising, Honolulu stationary	0	0	0
Midway Island falling, Honolulu stationary	7	3	43
Midway Island stationary, Honolulu rising	3	2	67
Midway Island stationary, Honolulu falling	6	2	33

TABLE B.—*Direction of the wind at 8 p. m. at Midway Island with 0.01 inch or more of precipitation at Honolulu within 24 hours, and Midway Island barometer above or below the average of 30.09 inches*

	Above average	Below average		Above average	Below average
N	1	3	SW	6	10
NE	37	12	W	0	2
N	15	5	NW	3	15
SE	18	9	Calm	1	1
S	1	0			

Discussion.—The author of the above paper need not feel discouraged in his attempt to deduce useful precepts for predicting the precipitation of Honolulu from the day-to-day pressure changes and other conditions at Midway Island, distant about 1,500 miles in a west-northwest direction.

As a general proposition, precipitation in the Hawaiian group, especially in the months November to April, is conditioned upon the intensity and frequency of the passage of barometric troughs across the islands during those months. Since these troughs, locally known as "Kona" storms, move as a rule from northwest to southeast, it is reasonable to suppose that Midway pressures should give some advance information of their arrival.

It is evident from the compilation on which Mr. Ramsay's Tables A and B are based, that Midway and Honolulu pressures are not synchronous in their day-to-day changes and that while the change from one day to the next at the two stations may be in the same sense in say, 40 per cent of the cases, the larger number of changes are in an opposite sense or there may be no change whatever at one of the stations. Owing to the low latitude of both stations the "accidental" fluctuations of the barometer are small in amplitude and infrequent as compared with stations in higher latitudes.

In the warm months Hawaiian rainfall is one of the purest orographic types that the world affords; it is, however, surprisingly variable considering that the islands are constantly swept by the northeast trades. It is the writer's belief that the exceptional heavy rains that occasionally fall in the warm months are due to a local and temporary strengthening of the trade winds and that this strengthening is brought about by the southeastward movement of anticyclones along a track about 600–800 miles distant in a north-northeast direction from the Hawaiian group of islands.

The North Pacific statistical anticyclone is augmented and intensified at all seasons of the year by the incoming and absorption of traveling anticyclones that approach from a westerly or northerly quarter. In winter there appears to be a distinct movement of offshoots from this anticyclone toward the north or northeast; in the warm season this movement is perhaps the same but is more difficult of identification. In exceptional seasons an easterly movement to the California coast has been suspected as the reason for exceptionally cloudy weather with fog on the coast and showers in higher altitudes.

Statistical evidence of the anticyclonic movement above mentioned is becoming easier to obtain by reason of an increased number of ship observations in the Pacific.—*A. J. H.*